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EXAMINER	
PETTITT, JOHN F	

ART UNIT	PAPER NUMBER
3744	

DATE MAILED: 07/25/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

SP

Office Action Summary	Application No.	Applicant(s)	
	10/825,024	KEITER ET AL.	
	Examiner	Art Unit	
	John Pettitt	3744	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *15 April 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-9* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3 and 5-9* is/are rejected.

7)☒ Claim(s) *4* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *4/15/2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *4/15/2004*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Claim Objections

Claims 5-6 and 7-9 are objected to because of the following informalities:

In regard to claim 5, the recitation "the applied piston drive signal" (line 14) lacks antecedent basis in the claim. To avoid confusion, the examiner suggests referring to the instant signal only as the "piston drive signal" as is maintained in the rest of the claim.

In regard to claim 7, the recitation "its stroke" (line 13) is not clear whether "its" is referring to the piston or prime mover. It is suggested that either --piston stroke-- or --prime mover stroke-- is used. In addition, there is insufficient antecedent basis for the recitation "the desired stroke" (line 15). The examiner assumes the applicants are referring to --the desired *piston* stroke-- as is adhered to in the rest of the claim.

In regard to claim 8, the applicants' placement of the phrase "and controlling the piston amplitude of oscillation" (line 10) is confusing. What is controlling the piston amplitude of oscillation; clearly not the "first controlled element including the prime mover and the heat pump". Rather, the examiner assumes that the phrase "and controlling the piston amplitude of oscillation" belongs in the preamble. As such, the following phrase is suggested, --(a) a first branch of the dynamic leg for controlling the piston amplitude of oscillation comprising: (i) a first controlled element including the prime mover and the heat pump; and (ii) a first ...-- as a replacement of "(a) a first branch of the dynamic leg comprising: (i) a first controlled element including the prime

mover and the heat pump and controlling the piston amplitude of oscillation; and (ii) a first…"

Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of the *second* paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 7-9 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicants regard as the invention.

In regard to claim 7, the term "thermal load" (lines 4-6) is used by the claim to mean --thermal mass--, while the accepted meaning is a form of heat. Additionally, the Specification defines the term "thermal load" as "cooling power demand" (page 3, lines 7-8). Therefore, since the use of the term within the claim does not comply with the accepted meaning nor the meaning used in the specification the claim is indefinite. Where the applicants act as their own lexicographer to specifically define a term of a claim contrary to its ordinary meaning, the written description must clearly redefine the claim term and set forth the uncommon definition so as to put one reasonably skilled in the art on notice that the applicants intended to so redefine that claim term. *Process Control Corp. v. HydReclaim Corp.*, 190 F.3d 1350, 1357, 52 USPQ2d 1029, 1033 (Fed. Cir. 1999).

In regard to claim 8, the term "an actuating signal" (line 21) creates confusion with the previous "actuating signal" (line 6 and 12). It is unclear whether this refers to the previous actuating signal cited in the claim or not. If it is a different signal, use another designation to distinguish each of the signals clearly. The examiner assumes it is the same signal cited previously in the claim.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-3 and 5-9 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Wu et al. (U.S. 5,535,593), Gully et al. (U.S. 5,032,772) and further in view of Dehne (U.S. 3,788,088).

In regard to claim 1, Wu et al. ('593) teach a method for controlling the temperature of a mass cooled by a free piston cryocooler. This method includes controlling the cooling power of the free piston cryocooler by modulating the piston stroke when the cooling power demands require a larger piston stroke than a selected minimum piston stroke. The selected minimum piston stroke in Wu et al. ('593) is that stroke length which would maintain the cooling power output of the cryocooler. The piston modulation is an increasing function of the difference between sensed mass

temperature and a command reference input temperature (see column 3, paragraph 2 / column 9, lines 27-39).

Wu et al. ('593) do not teach maintaining a selected minimum piston stroke length if the piston drive signal calls for a stroke length less than a minimum piston stroke length. However, Gully et al. ('772) teach maintaining a minimum piston stroke length "to maintain the compressor function at a level at least tending to compensate thermal losses" (column 4, lines 35-52).

Wu et al. ('593) also do not teach applying thermal energy to the mass when the piston drive signal is less than the selected minimum piston stroke (indicating that the cold end temperature remains below the temperature set point, even though the cryocooler is operating at the minimum cooling power output possible). Dehne (U.S. 3,788,088) teaches the historical use of electrical heaters to control the temperature of temperature-sensitive electronics on the cold end (column 9, lines 44-49).

Therefore, it would have been obvious to a person having ordinary skill in the art, at the time the invention was made, to combine the method of piston modulation taught by Wu et al. ('593) with

the step of maintaining the selected minimum piston stroke for the purpose of maintaining compressor operation as taught by Gully et al. ('772) and

the step of applying thermal energy to the mass for the purpose of controlling the mass temperature when the cooling power demands are less than the minimum cooling power of the cryocooler as taught by Dehne ('088). Simply put, it is known in the art to

maintain the compressor's operational limits and to heat the cold end when the cryocooler's cooling power is too high to maintain a desired temperature.

In regard to claim 2, Gully et al. ('772) teach the use of the compressor's operational limits (the minimum and maximum piston stroke length) in the method of modulating the piston stroke for the purpose of preventing the piston from colliding into the ends of the piston chamber (cylinder) or otherwise damaging the compressor's components (column 4, lines 1-6).

In regard to claim 3, the method of controlling the temperature of a mass with a heater as taught by Dehne ('088) inherently teaches increasing the heater power as an increasing function of the difference between the cooling power of the cryocooler and the cooling power demand.

In regard to claim 5, Wu et al. ('593) disclose a method for controlling the temperature of a mass cooled by a free piston cryocooler (10), the cryocooler having a piston (102) and a closed loop control system (170). The piston drive signal(s) (240 and 250) are derived from the difference between a set point signal (320) and a feedback signal (132) representing the mass temperature (T_m or 132). The remaining elements of claim 5 are met by the prior art as discussed in regard to claim 1 above.

In regard to claim 6, see claim 2 above.

In regard to claim 7, Wu et al. ('593) teach a free piston cryocooler (10) driven reciprocation by prime mover having a modulatable stroke (104); the cryocooler having a cold end and warm end, a feedback control system (30); the control system having temperature command input (320) for the desired cold end temperature; a summing

junction (shown as the receiving junction for 320 and 132) for generating an actuating signal (leaving the summing junction above) which represents the error between the command input (320) and the actual temperature (T_m or 132); a piston stroke modulator (300 and 310) for converting the actuating signal into a piston drive signal (400 and 410) representing a desire piston stroke; controlling the piston stroke when the desired piston stroke is greater than a selected minimum (the minimum piston stroke being that piston stroke which would maintain the current cooling power output).

Wu et al. ('593) teach a heater in thermal connection with the cold end of the cryocooler as a means for temperature control in and of itself, but they do not teach the above elements in combination with the heater. That is, Wu et al. ('593) teach either using a heater to control the cold end temperature or using piston stroke modulation. In addition to Wu ('593), Dehne (U.S. 3,788,088) directly teaches electrical heaters mounted on the cold end of a cryocooler connected to provide temperature control for temperature-sensitive electronics (column 9 lines 44-49). The power from these heaters can be modulated as an increasing function of the difference between the desired piston stroke and the minimum piston stroke to control the temperature of the cold end when the desired piston stroke is less than the minimum piston stroke (i.e. when the cooling power output is greater than the cooling power demand).

Wu et al. ('593) do not teach maintaining a selected minimum piston stroke length if the piston drive signal calls for a piston stroke length less than a minimum piston stroke length. However, it is known in the art that when modulating the piston stroke length of a compressor, the operational limits of the compressor must be

maintained to prevent damage to the compressor components and, "to maintain the compressor function at a level at least tending to compensate thermal losses" (Gully et al. (U.S. 5,032,772) -- column 4, lines 35-52).

Therefore, it would have been obvious to a person having ordinary skill in the art, at the time the invention was made, to combine the piston modulated cryocooler described by Wu et al. ('593) with the heaters taught by Dehne ('088) to provide temperature control of the cold end while still maintaining the piston stroke within compressor operational limits as taught by Gully et al. ('772) for the purpose of controlling the cold end temperature when the cooling power demands are less than the minimum cooling power of the cryocooler.

In regard to claim 8, Wu et al. ('593) teach a closed loop control system (30); a dynamic leg (comprising 20 and 30); a reference input for a temperature set point (320); a feedback leg including a temperature sensor on the mass being cooled (132, T_m); an actuating signal (370); a first controlled element comprising a prime mover (104) and a heat pump (10); a first control element (30) having an output connected to an input of the first controlled element.

Wu et al. ('593) do not teach a signal limiter that maintains the output of the first control element greater than a selected piston stroke and substantially corresponding to a minimum piston stroke. Gully et al. ('772) teach a differential amplifier whose output calls for a piston stroke length greater than a selected piston stoke limit (column 4, lines 50-53) and substantially corresponding to a minimum piston stroke (V_{TE}) for the purpose of maintaining the piston stroke within the compressor's operational limits.

Wu et al. ('593) do not teach a second dynamic leg with a heater (thermally connected to the mass) or a second control element, which controls the heater. Dehne ('088) directly teaches electrical heaters mounted on the cold end of a cryocooler connected to provide temperature control for temperature-sensitive electronics (column 9 lines 44-49). Adding a second parallel dynamic leg to the control system so as to include the heaters taught by Dehne ('088) so that

(1) when the actuating signal (i.e. the desired piston stroke) is greater than the selected piston stroke limit -- no heating power is added to the cold end;

and

(2) when the actuating signal is less than the selected piston stroke limit --

heater power is added as a decreasing function of the actuating signal (i.e. the desired piston stroke)

would be an obvious adjustment to the control system to provide a means of raising the temperature of the cold end faster than by piston modulation without adding undue heat to the cold end when piston modulation is sufficient.

Therefore, it would have been obvious to a person having ordinary skill in the art, at the time the invention was made, to combine the control system described by Wu et al. ('593) with the controlled heaters taught by Dehne ('088) to restrain piston modulation within the operational limits of the compressor and provide a means to quickly warm the cold end when desired.

In regard to claim 9, a control system comprising a microprocessor with associated storage wherein the storage contains control instructions and algorithms is common in the art as taught by Wu et al. ('593) (column 10, paragraph 2).

Allowable Subject Matter

Claim 4 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Remarks

As further support that applying heat or thermal energy to the cold end represents an obvious temperature control solution, consider the following:

Wu et al. (U.S. 5,535,593) teach controlling the temperature of a mass (cooled by a cryocooler) by adding heat to the mass (column 1, lines 54-58) for the purpose of simple temperature control. Additionally, Pundak (U.S. 6,397,605 B1) discloses the common use of heaters on the cold end of cryogenic equipment to remove frost layers quickly (column 2, lines 14-16). Nakahara et al. (U.S. 6,354,087 B1) describe how "a heater is placed at the cryogenic part of the refrigerator housed in the liquefied air storage vessel in order to melt or sublimate any solidified matter attaching to the cryogenic part" (column 4, lines 1-4). In all of these instances heaters are sought after for the same reason, to raise the temperature of the cold end without modulating the cooling power of the cryocooler (regardless of the specific reasons for avoiding cryocooler power modulation). Finally, heaters are *only* used when the cooling power of

the cryocooler is greater than the cooling power demands--otherwise they would be of no use in temperature control.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Chellis et al. (U.S. 4,543,793) teaches piston modulation of several types of cryogenic refrigerators; Young (US 4,553,398) teaches use of gas bearing lubrication; Livingstone et al. (U.S. 5,018,357) piston modulation of Free-piston cryocoolers involves ability to maintain as well as change piston stroke; Redlich (US 5,156,005) teaches piston modulation with free-piston cryocoolers; Beale (US 5,385,021) teaches to maintain compressor operating limits while modulating power output; Lester (US 5,606,870) teaches the disadvantages of a variable output cooling power source; Chase (US 6,098,409) teaches the specific tradeoffs associated with different temperature control methods.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Pettitt whose telephone number is 571-272-0771. The examiner can normally be reached on M-F 8a-4p.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Cheryl Tyler can be reached on 571-272-4834. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

JFP III

July 21, 2006

Cheryl J. Tyler
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